

INCREASED SHERMAN FUNCTION IN ELECTRON SPIN ANALYZERS USING A BULK THORIUM TARGET

J.J. McClelland, M.R. Scheinfein and D.T. Pierce

Electron Physics Group, National Institute of Standards and Technology
Gaithersburg, MD 20899 USA

Studies of collisions involving spin-polarized electrons have become increasingly prevalent in recent years. Of central importance to these studies are methods for measurement of the electron spin polarization. The most common method of spin polarization measurement, Mott scattering, involves large-angle scattering of an electron beam at high kinetic energy from a gold target. The spin polarization is inferred from the measured left-right asymmetry A_{LR} in the signals from two detectors situated at $\pm 120^\circ$ scattering angle.

The efficiency of a Mott analyzer is governed by the magnitude of the effective Sherman function S_{eff} , which is the value of A_{LR} for a 100% polarized beam, and the ratio of scattered intensity I to incident intensity I_0 . These quantities are combined into a figure of merit¹ $\mathcal{F} = S_{eff}^2 I/I_0$, which determines the signal-to-noise with which a polarization can be measured.

We have conducted a series of measurements using a 0.09 mm thick thorium disk as a scattering target.² The effective Sherman function was measured in a cylindrical retarding Mott analyzer³ as a function of incident energy and inelastic acceptance window. Thorium, at $Z = 90$, is expected to have a significantly higher Sherman function than gold ($Z = 79$) because of the dependence of the spin-orbit effect on Z . A Sherman function as much as 30% higher than that of gold was observed. Degradation of the Sherman function, due to multiple scattering arising from the bulk nature of the target, was not seen at small values of the inelastic acceptance window. This is thought to be a result of the fact that most of the multiple scattering in the backward direction is inelastic, which can be effectively eliminated by the retarding Mott analyzer.

Comparisons were made between the effective Sherman functions of the thorium target and a 1250 Å gold film. Measurements were made as a function of inelastic energy window V_{inel} over the range 25–500 V, and incident energy over the range 20–100 keV. Comparisons were also made with earlier measurements on gold,⁴ and with theoretical predictions.⁵ Figure 1 shows the measured values of S_{eff} for thorium and gold as a function of incident energy at $V_{inel} = 25$ V. Also shown are the earlier results for gold from Reference 4.

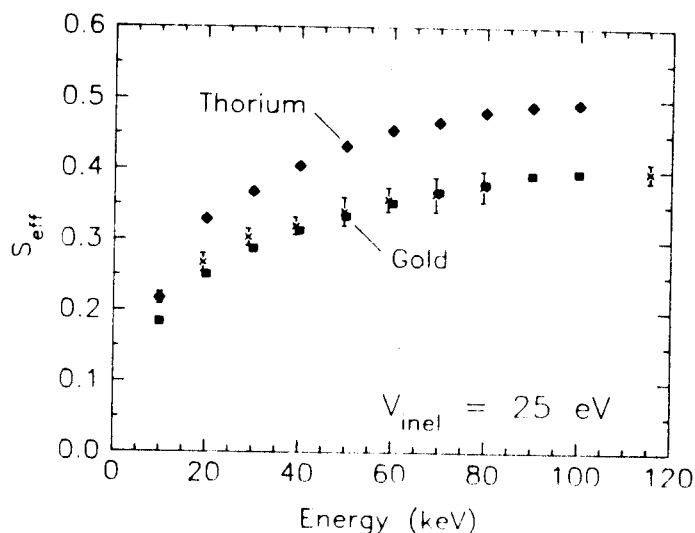


Figure 1. Effective Sherman function S_{eff} versus scattering energy. $V_{inel} = 25$ eV. Crosses represent data of Gray *et al.*⁴

The thorium effective Sherman function is seen to reach a value as high as 0.49 at 100 keV incident energy. This represents a significant increase over the gold Sherman function, which results in a greatly improved figure of merit. Agreement with the theoretical prediction of 0.485 is excellent. In addition, our measurements on gold reconfirm the earlier results of Gray *et al.*⁴

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